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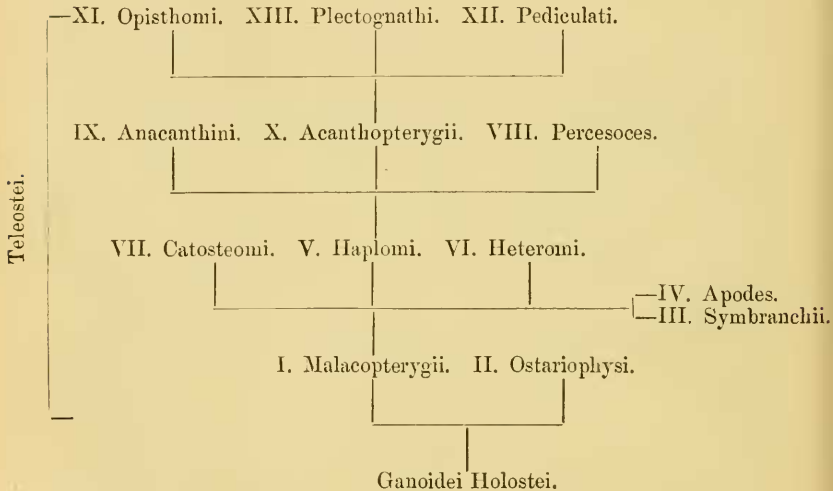
XIX.—*A Synopsis of the Suborders and Families of Teleostean Fishes.* By G. A. BOULENGER, F.R.S.

FOR several years I have been endeavouring to improve the classification of Teleostean Fishes, chiefly through a study of their skeletons, of which a large series has been prepared in the British Museum; and Dr. A. Smith Woodward has recently published his views on the arrangement of the fossil types of this order. The time has come to gather together the information thus obtained. The synopsis here offered was prepared two years ago for the fish-volume of the 'Cambridge Natural History,' but owing to circumstances over which I have had no control its publication in that work is still further delayed. Several important changes to my original scheme have been made during this lapse of time, owing to the work carried on in America by Drs. Gill, Jordan, and Starks, and in this country by my young colleague Mr. C. Tate Regan, whose criticisms on many points I gratefully acknowledge.

I need hardly say that I regard this new arrangement of an enormous and most difficult group, including close upon 12,000 species, as merely provisional, and I am fully aware that not a few groupings are nothing but card castles, which future investigations are likely to upset. But my aim has been to build up on phylogenetic lines, and as such I sincerely trust my attempt will be found a considerable improvement on the previous systems and serve as a basis for criticism.

The arrangement here proposed has been used in the 'Zoological Record' for 1902, which has just appeared.

The precise definition of the order Teleostei, as compared with the Holostean Ganoids, is a matter of some difficulty. The most important character appears to be the presence of an ossified supraoccipital bone. Remnants of primitive characters, such as Ganoid scales, fulcra, rudiments of a splenial bone, spiral valve to the intestine, multivalvular bulbus arteriosus, are still found in some lower Teleosteans, but no longer in that combination which characterizes the preceding Order. Although *Albula* is exceptional among all Teleosteans in having two transverse series of valves to the bulbus arteriosus instead of one, no Ganoid has fewer than three. The order Teleostei, thus defined, is divided into thirteen suborders, the probable relations of which are expressed in the following diagram:—



In the classification of Günther, which has been generally in use in this country for the last thirty-five years, the Teleosts were divided into six principal groups, regarded as of ordinal rank:—1. Acanthopterygii; 2. Acanthopterygii Pharyngognathi; 3. Anacanthini; 4. Physostomi; 5. Lophobranchii; 6. Plectognathi. Group 1 corresponds to Suborders VI. (part.), VII. (part.), VIII. (part.), X., XI., and XII. of the present classification; Group 2 to Suborder X. (part.); Group 3 to Suborders IX. and X. (part.); Group 4 to Suborders I., II., III., IV., V., VI. (part.), and VIII. (part.);

Group 5 to Suborder VII. (part.); and Group 6 to Suborder XIII.

Fuller definitions of the families, with an indication of the principal genera contained in each, will be given in the forthcoming seventh volume of the 'Cambridge Natural History.'

Suborder I. MALACOPTERYGII.

Air-bladder, if present, communicating with the digestive tract by a duct. Opercle well developed. Pectoral arch suspended from the skull; mesocoracoid arch present. Fins without spines, the ventrals abdominal, if present. Anterior vertebræ distinct, without Weberian ossicles.

This suborder, which corresponds to the Isospondyli and Scyphophori of Cope and to a part of the Isospondyli of A. S. Woodward, embraces the most generalized of the Teleosts, and is intimately connected with the Holostean Ganoids by the fossil forms which are placed at the base of the series of families. The physostomous condition of the air-bladder, the connexion of the pectoral arch with the skull, the presence of a mesocoracoid arch, the backward position of the many-rayed ventral fins, the normal condition of the anterior vertebræ, the absence of true spines to the fins, and the separation of the supraoccipital bone from the frontals by the parietals are primitive characters which occur combined in some families of this suborder only. The mesocoracoid arch is retained by the Ostariophysi, which differ in the remarkably modified condition of the anterior vertebræ, but it disappears in all other Teleosts, which gradually acquire a more forward position of the ventral fins and a reduction in the number of their rays, develop spines in the vertical fins, and lose the communication of the air-bladder with the outside.

The Malacopterygii may be divided into twenty-one families:—

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| I. Fins fringed with fulcra, or scales coated with ganoine; notochord usually continuous through the vertebræ (connecting forms between Ganoids and Teleosts). | |
| Vertebral centra not more than rings; fins with fulcra; scales rhombic, united by peg-and-socket | 1. <i>Pholidophoridae</i> †. |
| Vertebral centra not more than rings; fins with fulcra; scales cycloid | 2. <i>Archæomænidae</i> †. |
| Vertebral centra complete or with minute perforation; fins with fulcra; scales cycloid . . | 3. <i>Oligopleuridae</i> †. |
| Vertebral centra nearly complete, but with perforation; no fulcra; scales cycloid | 4. <i>Leptolepididae</i> †. |

† This sign indicates that the family is represented by fossil forms only.

II. Fins without fulcra; scales without ganoine; vertebral centra usually complete.

A. Supraoccipital separated from the frontals by the parietals.

1. Ventral fins with 10 to 16 rays.

- An intergular bone; parasphenoid narrow 5. *Elopidæ*.
- No intergular bone; parasphenoid very broad 6. *Albulidæ*.

2. Ventrals with not more than 7 rays.

a. Supratemporal very large, plate-like, covering the greater part of the parietal bone.

- Præmaxillary single, its posterior extremity free from the maxillary; symplectic absent; basis cranii simple 7. *Mormyridæ*.

- Præmaxillary paired, its posterior extremity firmly attached to the maxillary; symplectic present; basis cranii double 8. *Hyodontidæ*.

b. Supratemporal small; maxillary firmly attached to posterior extremity of præmaxillary.

- Præmaxillary paired; a large hole on each side of the skull, between the postfrontal and the squamosal; basis cranii double; suboperculum absent; ribs sessile 9. *Notopteridæ*.

- Præmaxillary paired; basis cranii simple; suboperculum reduced; ribs inserted on parapophyses 10. *Ostecoglossidæ*.

- Præmaxillary single; basis cranii simple; suboperculum and interoperculum absent; ribs inserted on parapophyses 11. *Pantodontidæ*.

c. Supratemporal small; maxillary movable; ribs sessile; ventral fins below the pectorals 12. *Ctenothrissidæ* †.

B. Supraoccipital in contact with frontals.

- 1. Interoperculum enormous; symplectic absent; basis cranii simple 13. *Phractolamidæ*.

- 2. Interoperculum normal; symplectic present; basis cranii double.

a. Teeth in sockets; maxillary firmly attached to præmaxillary.

- Symplectic exposed, fitting into a notch of the quadrate 14. *Saurodontidæ* †.

- Symplectic hidden between the quadrate and the hyomandibular 15. *Chirocentridæ*.

b. Teeth not in sockets.

- Postclavicle on outer side of clavicle; no adipose dorsal fin 16. *Clupeidæ*.

- Postclavicle on inner side of clavicle; an adipose dorsal fin 17. *Salmonidæ*.

- Postclavicle absent; no adipose dorsal fin 18. *Alepocephalidæ*.

3. Interoperculum normal; basis cranii simple.

- Maxillary large, toothed; præcaudal vertebrae without well-marked parapophyses; scales cycloid or absent; adipose dorsal fin present or absent 19. *Stomiatidæ*.

- Mouth small, toothless; vertebræ with strong parapophyses; head and body covered with spiny scales 20. *Gonorhynchidæ*.
 Mouth small, toothless; no symplectic; head and body naked 21. *Cromeriidæ*.

Suborder II. OSTARIOPHYSI.

Air-bladder, if well developed, communicating with the digestive tract by a duct. Pectoral arch suspended from the skull; mesocoracoid arch present. Fins without spines, or dorsal and pectoral with a single spine formed by the co-ossification of the segments of an articulated ray. The anterior four vertebræ strongly modified, often co-ossified and bearing a chain of small bones (Weberian ossicles) connecting the air-bladder with the ear.

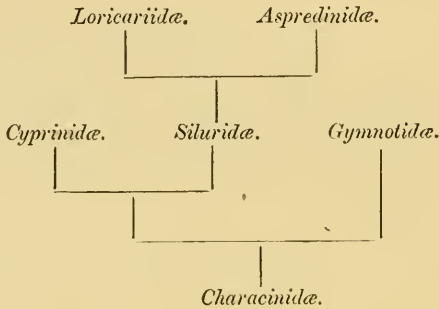
This is one of the most natural groups of the class Pisces, although its members are so diversified in outward appearance as to have been widely separated in the systems of older authors. It is to Sagemehl* that is due the credit of having first grouped, under the above name, the Characines, the Carps, the Catfishes, and the Gymnotids, the relations of which had been realized to a certain extent by Cope. But it was not until the homology throughout the group of the ossicula auditus, first described by E. H. Weber in 1820, had been demonstrated by Sagemehl that the justification for the course here followed appeared in its full strength, as such an agreement in the structure of so complicated and specialized an apparatus can only be the result of a community of descent of the families which are possessed of it. It is invariably the anterior four vertebræ that take part in the support of the Weberian apparatus. The first vertebra is much reduced; its upper arch is absent and replaced by the ossicles termed *claustrum* and *scaphium* †, the former being perhaps nothing but the modified neural arch, which fill in the space between the exoccipital and the neural arch of the second vertebra; the principal piece of the apparatus, the *tripus*, variable in form, is related to the third vertebra, of which it is regarded as a modified rib; a fibrous ligament extends from the anterior extremity or the *tripus* to the *scaphium*, and in this ligament is inserted the fourth piece, the *intercalarium*. The various forms of this suborder also show a complete agreement in the spinal nerves which pass through these ossicles.

* Morphol. Jahrb. x. 1885, p. 22.

† For the nomenclature of these ossicles, cf. Bridge and Haddon, Proc. Roy. Soc. xlvi. 1889, p. 310.

The parietal bones either separate the frontals from the supraoccipital or are fused with the latter.

This suborder is divided into six families. The Characiniids are the most generalized, and the others are probably derived from them in the manner expressed by the following diagram :—



I. Parietal bones distinct from the supraoccipital ; symplectic present ; ribs mostly sessile, all or the greater number of the præcaudal vertebræ without parapophyses.

- Mouth not protractile, usually toothed ; pharyngeal bones normal ; body scaly ; an adipose dorsal fin often present 1. *Characiniidae*.
- Mouth not protractile, usually toothed ; pharyngeal bones normal ; body eel-shaped, naked or scaly ; vent under the head or on the throat 2. *Gymnotidae*.
- Mouth usually more or less protractile, toothless ; lower pharyngeal bones large, falciform ; body naked or scaly ; no adipose dorsal fin 3. *Cyprinidae*.

II. Parietal bones usually fused with the supraoccipital ; symplectic absent ; body naked or with bony scutes ; mouth usually toothed, with barbels ; adipose dorsal fin often present.

- Ribs attached to strong parapophyses ; operculum well developed 4. *Siluridae*.
- Ribs sessile ; parapophyses absent ; operculum more or less developed ; mouth inferior 5. *Loricariidae*.
- Ribs sessile ; strong parapophyses to the vertebræ ; operculum absent 6. *Aspredinidae*.

Suborder III. SYMBRANCHII.

Eel-shaped fishes without paired fins, with the pectoral arch free or suspended from the skull and with the anterior vertebræ distinct, without Weberian ossicles. Gill-openings confluent into a single ventral slit. Air-bladder absent.

The structure of the skull conforms to that of typical Malacopterygians. The præmaxillary and maxillary are both well developed, the latter placed behind the former, and forming but a very small part of the oral border; the symplectic is present; the parietals form a long sagittal suture and separate the frontals from the supraoccipital. The vertebræ are very numerous, the præcaudals bearing very strong parapophyses, to which short slender ribs are attached. The skin is naked (*Symbranchidæ*) or covered with minute scales (*Amphipnoïdæ*), and the vertical fins are rudimentary, reduced to mere dermal folds.

Like the Apodes, these fishes are no doubt derived from some low type with abdominal ventral fins, but whether from the Malacopterygii or the Haplomi we have as yet no data from which to conclude.

Only two families:—

Post-temporal well developed, forked, attached to the skull	1. <i>Symbranchidæ</i> .
Post-temporal absent, the shoulder-girdle free from the skull	2. <i>Amphipnoïdæ</i> .

Suborder IV. A P O D E S.

Air-bladder, if present, communicating with the digestive tract by a duct. Præmaxillaries absent; the maxillaries, if present, separated on the median line by the coalesced ethmoid and vomer. Pectoral arch, if present, not connected with and remote from the skull; mesocoracoid arch absent. Fins without spines, the ventrals absent. Anterior vertebræ distinct, without Weberian ossicles.

The Apodes, or Eels, are elongate serpentiform fishes with naked skin or with minute scales imbedded in the skin, the opercular bones small and completely hidden under the integument, narrow or minute gill-openings, the vertical fins, if present, confluent behind or separated by the projecting tip of the tail. The pterygo-palatine arch is often reduced or absent, and there is no distinct symplectic; the supraoccipital bone is small, separated from the frontals by the parietals, which meet on the middle line. The vertebræ are very numerous (up to 225) and the præcaudals bear strong parapophyses, to which short slender ribs may be attached; epineurals are sometimes present.

The five families into which this suborder is divided show remarkable degrees of simplification in the structure of the

skull, through reduction or loss of either the maxillary or the pterygo-palatine arches.

Five families:—

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|---|------------------------------|
| <p>Maxillaries present, separated on the median line by the ethmo-vomer; palato-pterygoid present, connected with the hyomandibular and quadrate; gill-clefts separate, opening into the pharynx by wide slits; tongue present; vent far removed from the head.</p> | 1. <i>Anguillidæ</i> . |
| <p>Distinguished from the preceding by the position of the vent, which is close to, or at no great distance from, the gill-openings</p> | 2. <i>Nemichthyidæ</i> . |
| <p>Maxillaries narrowly separated on the median line, their extremity strongly attached by ligament to the mandible; pterygo-palatine arch absent; gill-openings externally confluent into a single ventral slit.</p> | 3. <i>Synaphobranchidæ</i> . |
| <p>Maxillaries narrowly separated on the median line, extremely elongate; mouth enormous; pterygo-palatine arch absent; hyomandibular arch slender and movably articulated to the cranium; branchial arches far behind the skull</p> | 4. <i>Saccopharyngidæ</i> . |
| <p>Maxillaries absent, replaced by the palato-pterygoid, the mouth bordered by the latter and the ethmo-vomer; palato-pterygoid bone separated from hyomandibular arch; branchial openings into the pharynx narrow slits; no tongue</p> | 5. <i>Muraenidæ</i> . |

Suborder V. HAPLOMI.

Air-bladder, if present, communicating with the digestive tract by a duct. Opercle well developed. Pectoral arch suspended from the skull; no mesocoracoid arch. Fins usually without, rarely with a few spines; ventrals abdominal, if present. Anterior vertebrae distinct, without Weberian ossicles.

The absence of the mesocoracoid arch distinguishes the Haplomi from the Malacopterygii, with which they are united by various authors. They lead to the Percosoces through the Cyprinodontids, and to the Lower Acanthopterygians, such as the Berycids, through the Scopelids, Stephanoberycids, and Percopsids, as is evidenced by the structure of the mouth and the forward position in some of the genera of the ventral fins, which, however, are never attached to the pectoral girdle. Most of the forms which are here included inhabit either fresh waters or the deep sea.

Fourteen families :—

I. Parietals separating the frontals from the supraoccipital; post-temporal simple; præcaudal vertebræ with autogenous parapophyses.

Margin of the upper jaw formed by the præmaxillaries and the maxillaries; basis cranii simple; no adipose dorsal fin 1. *Galaxiidæ*.

Margin of the upper jaw formed by the præmaxillaries only; basis cranii double; adipose dorsal fin present 2. *Haplochitonidæ*.

II. Frontals in contact with the supraoccipital.

A. Præcaudal vertebræ without parapophyses.

1. Margin of the upper jaw formed by the præmaxillaries and the maxillaries.

Body without or with minute scales, usually with rows of scutes; adipose dorsal fin usually present 3. *Enchodontidæ* †.

Body scaly; post-temporal forked; no adipose dorsal fin; ventrals with 6 to 11 rays 4. *Esocidæ*.

Body scaly; post-temporal incompletely ossified; pectoral fin without pterygials; no adipose dorsal fin; ventrals with 3 rays only. 5. *Dalliidæ*.

2. Maxillaries excluded from the oral border.

a. Adipose dorsal fin usually present; ventral fin with 7 to 10 rays.

Post-temporal forked; dorsal fin formed of articulated rays 6. *Scopelidæ*.

Post-temporal simple; dorsal fin very long, formed of slender, non-articulated, simple or bifid rays 7. *Alepidosauridæ*.

b. No adipose dorsal fin; head and mouth enormous, dentition feeble; body naked; ventral fins, if present, with 5 rays.

8. *Cetomimidæ*.

B. Præcaudal vertebræ with well-developed parapophyses; maxillaries excluded from the oral border.

1. Dorsal and anal fins without spines; scales cycloid, or with erect spines; no adipose dorsal fin.

Mouth not protractile; ventral fins far forward, with 7 to 17 rays 9. *Chirothricidæ* †.

Mouth not protractile; ventral fins remote from the pectorals, with 9 rays. 10. *Kueriidæ*.

Mouth protractile; ventral fins, if present, with 5 to 7 rays. 11. *Cyprinodontidæ*.

Mouth scarcely protractile; ventral fins rudimentary or absent; vent close to the gills. 12. *Amblyopsidæ*.

Mouth slightly protractile; ventral fins with 5 or 6 rays 13. *Stephanoberycidæ*.

2. Dorsal and anal fins with true spines; scales ctenoid; an adipose dorsal fin; ventral fins with 9 rays. 14. *Percopsidæ*.

Suborder VI. HETEROMI.

Air-bladder without open duct. Opercle well developed; parietal bones separating the frontals from the supraoccipital. Pectoral arch suspended from the supraoccipital or the epiotic, the post-temporal small and simple or replaced by a ligament; no mesocoracoid. Ventral fins abdominal, if present.

The Halosauridæ and Notacanthidæ are deep-sea fishes of obscure affinities. In the abdominal position of the many-rayed ventral fins and in the absence of the mesocoracoid arch they agree with the Haplomi; but if, as the investigations of Günther lead us to believe*, there is really no open communication between the air-bladder and the digestive tract, they should be removed from this physostomous suborder. The two families have many characters in common, such as the attachment and structure of the pectoral arch, which is devoid of a postclavicle, the position of the pectoral fins high up the sides, the strong parapophysis inserted very low down on the centre of the vertebræ, the extent of the parietal bones, which meet in a sagittal suture and separate the frontals from the supraoccipital. The recent discovery of a third family, the Lipogenyidæ, which in the structure of the dorsal fin is so exactly intermediate between the two others, has lessened the gap between the Lyomeri (Halosauridæ) and Heteromi (Notacanthidæ) of Gill, which I propose to unite in a suborder under the latter name. These fishes are no doubt derived from forms in which a separate caudal fin existed; such a type must have been near the Dercetidæ, as defined by A. S. Woodward, which may provisionally be placed here.

There is a fifth family which may be placed in this suborder, the Fierasferidæ, the structure of which has been exquisitely described and figured by Emery. Hitherto placed with or near the Ophidiidæ, they differ widely from them, as well as from all other Acanthopterygians, in the conformation of the skull, the supraoccipital being separated

* Vaillant was inclined to take a different view, but with considerable diffidence, owing to his inability actually to trace an open duct. I believe Günther to be right on this point, as well as in his account of the suspension of the pectoral arch in *Notacanthus*, which I have been able to verify. Besides, Mr. W. S. Rowntree, who has great experience in these matters, has kindly examined at my request a well-preserved example of *Halosauropsis macrochir*, and informs me that "the air-bladder passes anteriorly into a tapering band of tissue which ends in a thread-like ligament attached to the stomach near its posterior end and in the mid-dorsal line—not to the œsophagus; no trace of an open communication could be found."

from the frontals by the parietals, which form a long median suture. This is a feature which has only been observed in fishes with abdominal ventral fins; and although the total absence of these fins in *Fierasfer* deprives us of an important criterion in deciding on its affinities, I am inclined to regard this family as derived from an abdominal type. The conformation of the pectoral arch has much in common with that of the Halosaurs, and, notwithstanding the interpretation that has been given to the bones at the back of the cranium in the latter type, the same may be said in a general way of the skull.

As pointed out by Emery, the very anterior position of the vent in the *Fierasferidæ* is directly related to the curious mode of life of these fishes, and the analogous condition obtained in various families, such as the *Gymnarchidæ*, *Nemichthyidæ*, *Amblyopsidæ*, and *Aphredoderidæ*, shows it to be of relatively small importance.

Five families:—

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|---|--------------------------------|
| <p>Ordinary scales small or wanting, but two or more continuous series of enlarged scutes along each side; mouth large, præmaxillaries apparently forming the greater part of the upper border of the mouth, which is toothed; opercular apparatus complete; dorsal fin more or less extended, without spines; anal short; caudal separate; ventrals with not less than 7 or 8 rays</p> | <p>1. <i>Dercetidæ</i> †.</p> |
| <p>Body covered with cycloid scales, the tail tapering to a point, without caudal fin; head with scales; mouth moderate, bordered by the præmaxillaries and the maxillaries, both toothed; suborbitals large; præopercle rudimentary; dorsal fin short, without spines; ventrals formed of 9 or 10 soft rays; anal very long, without spines, extending to the end of the tail</p> | <p>2. <i>Halosauridæ</i>.</p> |
| <p>Similar to the preceding, but with a toothless, roundish inferior mouth and with the short dorsal and the long anal formed partly of spines and partly of soft rays; ventrals with 3 spines and 7 soft rays</p> | <p>3. <i>Lipogenyidæ</i>.</p> |
| <p>Body covered with cycloid scales, the tail tapering to a point, without caudal fin; head with scales; mouth small, inferior, bordered by the præmaxillaries only; jaws toothed; no suborbitals; præoperculum small; post-temporal replaced by ligament; dorsal fin formed of a series of short disconnected spines; anal very long, formed partly of spines and partly of soft rays; ventrals with 1 to 5 spines and 7 to 10 soft rays</p> | <p>4. <i>Notacanthidæ</i>.</p> |
| <p>Body extremely attenuate, naked; no caudal fin; mouth small, inferior, bordered by the præmax-</p> | |

illaries; jaws toothed; no suborbitals; præoperculum well developed; dorsal and anal very long, formed of soft rays; ventrals absent; vent immediately behind the gill-opening 5. *Fierasferidæ*.

Suborder VII. CATOSTEOMI.

Air-bladder, if present, without open duct. Parietal bones, if present, separated by the supraoccipital. Pectoral arch suspended from the skull; no mesocoracoid arch; coracoid usually very large, or produced posteriorly. Ventral fins, if present, abdominal, or pelvis attached to the coracoid bones.

The mouth is bordered by the præmaxillaries, or by the præmaxillaries and a small portion of the maxillaries. Air-bladder present, except in the Solenostomidæ and Pegasidæ.

Following the suggestions of Kner and Steindachner and Cope to their logical conclusion, A. S. Woodward has united the Lophobranchs of Cuvier with the Hemibranchs of Cope, a course which seems fully justified, and has received further support from the recent investigations of Swinnerton*, who has proposed to unite the two groups under the new name of Thoracostei. The structure of the Lophobranchs (Solenostomidæ and Syngnathidæ) shows that these fishes are only extremely specialized forms of the group of which the Sticklebacks are the well-known type, and the character of the "tufted" gills alone is surely not of sufficiently great importance to warrant the retention of the Lophobranchii as a division equivalent to the suborders adopted in the present classification. Besides, as recently pointed out by A. Huot†, there is no fundamental difference, only one of degree, between the so-called tufted gill and the normal type; each "tuft" corresponds to one branchial lamella, and at a certain stage of development the disposition of the branchial lamellæ is the same in a *Syngnathus* and an ordinary Teleostean. I have recently attempted to show‡ that the Lamprididæ are related to the Hemibranchii, although sufficiently distinct to warrant the establishment of a division, named Selenichthyes§.

The affinities of the Lamprididæ are very doubtful. *Lampris* has usually been placed with the Acanthopterygians, a

* Quart. Journ. Micr. Sci. xlv. 1902, p. 503.

† Ann. Sci. Nat. (8) xiv. 1902, p. 197.

‡ Ann. & Mag. Nat. Hist. (7) x. 1902, p. 147.

§ E. C. Starks, in an important paper (P. U.S. Nat. Mus. xxv. 1902, p. 619), has shown that the so-called "infraclavicle" of sticklebacks and allies does not exist as a distinct element. The definition of the Cato-steomi as I had originally drawn it up has accordingly been modified.

view which is still upheld by Gill *. I now agree with this high authority in regarding the bone which I took for an infraclavicle as a much developed coracoid, and the bone termed by me the coracoid as a pterygial. But it has also been shown, by Starks, that such a thing as an infraclavicle does not exist even in the stickleback, the bone so-called being only a part of the coracoid; and as, in most of the sticklebacks, the pelvic bones join the latter, the resemblance between them and *Lampris* remains. As I have previously pointed out, the absence of spines in the fins and the position of the ventral fins, together with the great number of rays in the latter, which is only met with in the lower Teleosteans, are characters which necessitate the removal of *Lampris* from the Acanthopterygians, and I cannot find a better place for them than near the Gastrosteidæ.

The whole question of the arrangement of the Physoclists with abdominal ventrals (*Catosteomi* and *Percesoces*) is, I feel, much in need of revision, and it may be found advisable to break up this group into a greater number of suborders, in which case the Selenichthyes would stand by themselves; the Hemibranchii and Lophobranchii would be united under the former name, as proposed by Woodward, or under that of Thoracostei (Swinnerton) or Phthinobranchii (Hay).

Eleven families:—

- I. Præoperculum and symplectic distinct; branchial apparatus fully developed, gills pectinate; mouth terminal, toothless; post-temporal forked, free; pelvic bones connected with scapular arch, vertical fins with 15 to 17 rays; ribs long, sessile; fins without spines. (SELENICHTHYES.) 1. *Lamprididæ*.
- II. Præoperculum and symplectic distinct, latter much elongate; branchial apparatus more or less reduced, gills pectinated; post-temporal simple, immovable; mouth terminal. (HEMIBRANCHII.)
 - A. Mouth toothed.
 1. Pelvic bones close to or connected with scapular arch; spinous dorsal represented by isolated spines.
 - Snout conical or but slightly tubiform; ventral fins with one spine and one or two soft rays; ribs slender, free; anterior vertebræ not enlarged. 2. *Gastrosteidæ*.
 - Snout tubiform; ventral fins with one spine and four soft rays; ribs flattened, fused with the lateral bony shields; anterior vertebræ not enlarged. 3. *Aulorhynchidæ*.
 - Snout tubiform; ribs slender, free; first vertebra enlarged. 4. *Protosyngnathidæ* †.

* Proc. U.S. Nat. Mus. xxvi. 1903, p. 915.

2. Pelvic bones not connected with scapular arch; ventrals without spine, with 5 or 6 rays; snout tubiform; first vertebra very elongate, formed by the fusion of several.

Isolated dorsal spines; body scaly 5. *Aulostomatidæ*.
 No dorsal spines; body naked 6. *Fistulariidæ*.

- B. Mouth toothless; snout tubiform; two short dorsal fins, the first with a few spines; ventral fins with 3 to 5 rays; anterior vertebrae elongate.

Body covered with bony shields and small rough scales 7. *Centriscidæ*.
 Body completely cuirassed by bony shields, which are fused with the endoskeleton .. 8. *Amphisilidæ*.

- III. Præoperculum absent; symplectic much elongate; branchial apparatus more or less reduced; gill-lamellæ reduced in number and enlarged, forming rounded lobes; post-temporal simple, immovably attached to the skull; mouth toothless, at the end of a tubiform snout; body covered with bony plates. (LORHOBRANCHII.)

Two dorsal fins; ventral fins present, with 7 rays; gill-openings wide; exoskeleton of large star-like plates 9. *Solenostomidæ*.
 A single dorsal fin; no ventral fins; gill-openings very small; exoskeleton in the form of rings 10. *Syngnathidæ*.

- IV. Præoperculum and symplectic absent; gills pectinated; mouth inferior, toothless; body entirely covered with bony plates; ventral fin with 2 or 3 rays. (HYPOSTOMIDES.)
 11. *Pegasidæ*.

Suborder VIII. PERCESOCES.

Air-bladder, if present, without open duct. Parietal bones separated by the supraoccipital. Pectoral arch suspended from the skull; no mesocoracoid arch. Ventral fins, if present, abdominal, or at least with the pelvic bones not solidly attached to the clavicular arch.

This group connects the Haplomi with the Acanthopterygii, the Scombresocidæ being somewhat related to the Cyprinodontidæ *, whilst the Anabantidæ show distinct affinity to the

* Swinnerton (Quart. Journ. Micr. Sci. xlv. 1902, p. 554) has pointed out that the skull of the Scombresoces belongs to what he terms the Acrartete type (*e. g.* in which the attachment of the palatine cartilage or its derivatives is confined to the pre-ethmoid cornua), whilst the other Percesoces examined by him, as well as the Cyprinodonts, are Disartete (the attachment being at the par-ethmoid and pre-ethmoid cornua); but the character is so indistinctly defined in some adult Cyprinodonts, that I feel some diffidence in making use of this character for systematic purposes in the present state of our knowledge.

Osphromenidæ in the following suborder. Other families, previously included among the Scombriform Acanthopterygians, are placed here on the assumption that the loose attachment of the pelvic bones to the clavicles is a primitive character, and not the result of degeneration, such as occurs in some cases among the Acanthopterygians. Although this suborder is perhaps only an artificial association, it must be borne in mind that, notwithstanding the very wide divergence which exists between the first and last families, however dissimilar their members appear to be at first sight, a gradual passage may be traced connecting the most aberrant types.

Twelve families :—

I. Ventral fins, if present, inserted far behind the pectorals; no spines to the fins.

Ribs attached to the extremity of much-developed parapophyses; lower pharyngeal bones completely united; pectoral fins inserted very high up. 1. *Scombrosociidæ*.

Ribs mostly sessile; lower pharyngeal bones distinct; pectoral fins nearer the ventral than the dorsal line 2. *Ammodytidæ*.

II. Ventral fins, if present, more or less approximated to the pectorals.

A. Two well-developed dorsal fins, the anterior small and formed, at least in part, of spinous rays.

1. Ribs attached to strong parapophyses.

Pelvic bones free or connected with the clavicles by ligament; pectoral fins inserted high up. 3. *Atherinidæ*.

Pelvic bones suspended from the postclavicles; pectoral fins inserted very high up; teeth very feeble or absent 4. *Mugilidæ*.

Pelvic bones suspended from the postclavicles; pectoral fins nearer the ventral than the dorsal line, with detached lower rays 5. *Polynemidæ*.

Pelvic bones connected with the clavicles by ligament; pectoral fins nearer the ventral than the dorsal line; dentition powerful, cardi-form; scales minute or absent 6. *Chiasmodontidæ*.

2. Anterior ribs sessile; pelvic bones not connected with the scapular arch; pectoral fins nearer the ventral than the dorsal line 7. *Sphyrænidæ*.

B. Spinous dorsal, if present, connected with the soft.

1. Anterior vertebrae without parapophyses; scales on head, if present, small.

Oesophagus with lateral sacs which are beset with papillæ internally; spinous dorsal long; scales rhomboidal, in oblique transverse series; pelvic bones free 8. *Tetragonuridæ*.

Œsophagus with lateral sacs which are beset with toothed papillæ internally; spinous dorsal, if distinct, shorter than the soft dorsal; scales moderate or small, cycloid, often deciduous. 9. *Stromateidæ*.

No sacs in the œsophagus; fins without spines; scales very small or absent 10. *Icosteidæ*.

2. All or all but the two anterior vertebræ with parapophyses; scales on head large; a suprabranchial cavity.

No spines to the fins 11. *Ophiocephalidæ*.

Strong spines to the dorsal, anal, and ventral fins. 12. *Anabantidæ*.

Suborder IX. ANACANTHINI.

Air-bladder without open duct. Parietal bones separated by the supraoccipital; prootic and exoccipital separated by the enlarged opisthotic. Pectoral arch suspended from the skull; no mesocoracoid arch. Ventral fins below or in front of the pectorals, the pelvic bones posterior to the clavicular symphysis and only loosely attached to it by ligament.

Fins without spines; caudal, if present, without expanded hypural, perfectly symmetrical, and supported by the neural and hæmal spines of the posterior vertebræ and by basal bones similar to those supporting the dorsal and anal rays. This type of caudal fin must be regarded, as I have pointed out *, as secondary, the Gadidæ being no doubt derived from fishes like the Macruridæ, in which the homocercal fin had been lost. The scapular foramen or fenestra is nearly always between the scapular and coracoid bones, as in the Trachinidæ and several allied families, not in the coracoid, as in the other Acanthopterygians. The first two vertebræ have no epipleurals.

Mr. C. Tate Regan †, who has recently given a good definition of the Anacanthini, divides them into three families, which are here adopted:—

Ventral fins below the pectorals, with 7 to 12 rays; no caudal fin 1. *Macruridæ*.

Ventral fins jugular, with 1 to 9 rays; caudal fin more or less distinct (diphycercal or isocercal). 2. *Gadidæ*.

Ventral fins jugular, with 5 rays; no caudal fin; pectoral pterygials in increased number (10); scales as in the Anguillidæ 3. *Murænolepididæ*.

* Ann. & Mag. Nat. Hist. (7) x. 1902, p. 295.

† Op. cit. xi. 1903, p. 460.

Suborder X. ACANTHOPTERYGII.

Air-bladder usually without open duct. Opercle well developed; supraoccipital in contact with the frontals. Pectoral arch suspended from the skull; no mesocoracoid. Ventral fins thoracic or jugular, the pelvic bones more or less firmly attached to the clavicular arch. Gill-opening usually large; if small, in front of or above the base of the pectoral fin.

The character from which this suborder, the most comprehensive of the whole class, derives its name, viz. the presence of non-articulated, more or less pungent rays in the dorsal and anal fins, is by no means universal, exceptions to the rule being numerous. The mouth is usually bordered by the premaxillaries to the exclusion of the maxillaries, and if these should, by exception, enter the oral edge, they are always toothless. The ventral fins are sometimes inserted at some distance behind the base of the pectorals (*Haplodactylidæ*, *Platycephalidæ*), in which case, however, this is merely due to the elongation of the pelvic bones, which are solidly attached to the clavicular arch. The suborder is broken up into 9 divisions, which follow in somewhat arbitrary order, the natural affinities being opposed to a linear arrangement.

I. No suborbital stay, or process extending from the suborbital bones towards the preoperculum; basis cranii double in the symmetrical forms. Primary shoulder-girdle composed of a perforate scapula and a coracoid; of the four or five pterygials, or basal bones of the pectoral fins, only one or two are in contact with the coracoid; ventral fins thoracic.

Rays of the caudal fin not strongly forked at the base; hypural usually with a basal spine or knob-like process on each side; epipleural bones usually inserted on the parapophyses or on the ribs; dorsal fin usually with strong spines; caudal peduncle rarely much constricted

I. PERCIFORMES.

Rays of the caudal fin strongly forked at the base, embracing a considerable portion of the hypural, which always bears a basal spine; epipleural bones usually inserted on the centra or on the parapophyses, rarely on the ribs; dorsal spines feeble or detached; caudal peduncle much constricted; scales usually very small or absent

II. SCOMBRIFORMES.

Rays of the caudal fin not strongly forked at the base, no hypural spine, and ventral fins with one spine and six to eight soft rays, or cranium asymmetrical

III. ZEORHOMBI.

II. No suborbital stay; basis cranii double; scapula absent, the pterygials inserted on the coracoid; ventral fins thoracic.

IV. KURTIFORMES.

- III. No suborbital stay; basis cranii simple; scapula and coracoid more or less reduced, sometimes vestigial; pterygials large, only one or two in contact with the coracoid; ventral fins thoracic.
V. GOBIFORMES.
- IV. No suborbital stay; basis cranii simple; a perforate scapula; three pterygials in contact with the coracoid; ventral fins thoracic; a suctorial transversely laminated disk on the upper surface of the head VI. DISCOCEPHALI.
- V. A suborbital stay, the second suborbital bone being more or less produced on the cheek or joining the præoperculum; ventral fins thoracic VII. SCLEROPAREI.
- VI. No suborbital stay; ventral fins usually jugular or mental, or, if thoracic, structure of the pectoral arch differing from that ascribed to the first five divisions of this Synopsis.
- Pectoral fin with vertical or subvertical base; anal fin usually elongate, rarely small VIII. JUGULARES.
- Pectoral fin with horizontal or subhorizontal base; body exceedingly compressed; dorsal fin with all the rays simple; anal fin absent or very small IX. TÆNIOSOMI.

Division I. PERCIFORMES.

No bony stay for the præoperculum. Basis cranii double. Spinous dorsal usually well developed. None of the epipleural bones attached to the centra of the vertebræ in the præcaudal region. Pectoral arch with well-developed scapula and coracoid, the former pierced by a foramen or fenestra; pterygials longer than broad, more or less regularly hour-glass-shaped, 4 or 5 in number, one or two of which are in contact with the coracoid. Ventral fins thoracic.

This large group, consisting chiefly of marine forms, has members in all parts of the world, with the exception of the Arctic and Antarctic regions, and was already represented by numerous Berycidæ and a few Serranidæ and Scorpididæ in the Upper Cretaceous. The division into families, capable of rigid definition, is a task of considerable difficulty, and the necessities of a linear arrangement result in the breaking up of some natural sequences. Thus it appears highly probable that the Scorpididæ, themselves derived, together with the Serranidæ, from the Berycidæ, lead to the Carangidæ in the division Scombriformes, whilst a nearly perfect passage can be traced between the Acanthuridæ of this division and the Balistidæ among the Plectognaths.

Thirty-six families:—

I. Gills four, a slit behind the fourth.

A. Two nostrils on each side.

1. Ventrals with one spine and 6 to 13 soft rays.

1. *Berycidæ*.

- 2. Ventrals with not more than 5 soft rays.
 - a. Lower pharyngeal bones not completely united, showing at least a median suture.
 - a. Gill-membranes free from isthmus.
 - * Ventrals little if at all behind the pectorals.
 - † Third vertebra without transverse processes or with sessile ribs.
 - ‡ A more or less developed subocular shelf, or inner lamina of the suborbitals supporting the eyeball, sometimes reduced to a mere process of the second suborbital.
 - § Ribs inserted on the transverse processes, when these are developed.

- Body covered with very large bony scales; ventrals with a very strong spine and 2 or 3 very short soft rays 2. *Monocentridæ*.
- Dorsal very short, with few graduated, adnate spines; anal very long 3. *Pempheridæ*.
- Spinous dorsal usually well developed, soft dorsal usually not much more developed than the anal; palate usually toothed. 11. *Serranidæ*.
- Dorsal and anal fins elongate and formed mostly of articulated soft rays, the spines feeble and few 12. *Pseudochromididæ*.
- Dorsal and anal fins much elongate, without distinct spines; body band-like 13. *Cepolidæ*.
- Teeth in the jaws fused to form a beak 14. *Hoplognathidæ*.
- Soft dorsal and anal much elongate; a separate spinous dorsal 15. *Sillaginidæ*.
- Soft dorsal much longer than the anal; a separate spinous dorsal 16. *Sciænidæ*.

§§ Ribs mostly sessile, behind the parapophyses; body deep; mouth moderately large and protractile.

- Supratemporal forked, distinct from skull 25. *Scorpididæ*.
- Supratemporal completely ankylosed to the skull; mouth very protractile 26. *Caproidæ*.

‡‡ No subocular shelf.

§ Ribs mostly sessile, behind the parapophyses; anal spines 3 to 14.

- Teeth conical; palate toothed; mouth freely protractile 4. *Centrarchidæ*.
- Teeth incisor-like; fins densely scaled 5. *Cyphosidæ*.
- Teeth conical; palate toothless. 6. *Lobotidæ*.
- Maxillary very slender, mouth very protractile. 7. *Toxotidæ*.
- No entopterygoid; mouth very protractile 8. *Nandidæ*.

§§ Ribs inserted on the transverse processes when these are developed; not more than 3 anal spines.

- Mouth not or but feebly protractile; palate toothed; spinous dorsal usually longer than the soft; anal with 1 or 2 spines. 9. *Percidæ*.
- Mouth moderately protractile; palate toothed; spinous dorsal not longer than the soft; anal with 2 or 3 spines 10. *Aeropomatidæ*.

- Mouth very protractile, præmaxillary with an upward lateral process; palate toothless. 17. *Gerridae*.
- Mouth moderately protractile; palate toothless; anal longer than soft dorsal; body scaly. 18. *Lactariidae*.
- Mouth moderately protractile; palate toothless; anal much longer than soft dorsal; body naked 19. *Trichodontidae*.
- †† Transverse processes developed on the third vertebra and bearing the rib; palate usually toothless.
- No subocular shelf; teeth small 22. *Pristipomatidae*.
- A subocular shelf; teeth often either cutting in front or molar-like on the sides 23. *Sparidae*.
- A subocular shelf; teeth very small or absent; a pair of barbels on the throat 24. *Mullidae*.
- ** Ventrals rather far behind the base of the pectorals; lower pectoral rays unbranched, often thickened; no subocular shelf.
- Anal fin nearly as long as the soft dorsal 20. *Lafridae*.
- Anal fin much shorter than the soft dorsal 21. *Haplodactylidae*. —
- β. Gill-membranes attached to the isthmus.
- * Scales well developed; vertebrae 24 or more.
- A subocular shelf; mouth small; palate toothless 27. *Chaetodontidae*.
- No subocular shelf; mouth small; palate toothless 28. *Drepanidae*.
- Subocular shelf more or less developed; a superbranchial respiratory organ 31. *Osphromenidae*. —
- ** Scales minute; mouth small; vertebrae 22 or 23.
- Post-temporal not distinctly forked; vertebrae with strong transverse processes; ventrals with 1 spine and 2 to 5 soft rays 29. *Acanthuridae*.
- Post-temporal forked; vertebrae without transverse processes; ventrals with 2 spines and 3 soft rays between them 30. *Teuthididae*.
- b. Lower pharyngeals completely united into one bone, without median suture 32. *Embiotocidae*.
- B. A single nostril on each side; lower pharyngeal bones more or less completely united, but with persistent suture; no subocular shelf; palate toothless 33. *Cichlidae*.
- II. Gills three and a half; lower pharyngeals completely united into one bone, without median suture; palate toothless.
- A single nostril on each side; teeth conical or incisor-like; a subocular shelf 34. *Pomacentridae*.
- Two nostrils on each side; anterior teeth usually strong and canine-like; teeth on pharyngeal bones conical or tubercular; no subocular shelf 35. *Labridae*.
- Two nostrils on each side; anterior teeth more or less coalesced into a beak; teeth on pharyngeal bones flat, tessellated; no subocular shelf. 36. *Scaridae*.

Division II. SCOMBRIFORMES.

No bony stay for the præopercle. Spinous dorsal, if distinct, formed of short or feeble, slender spines. Epipleurals usually attached to the centra when ribs are sessile, or to the parapophyses of the vertebræ, rarely to the ribs. Pectoral arch similar to that of the Perciformes, but pterygials sometimes more abbreviated. Ventral fins thoracic. Caudal fin, if well developed, with very numerous rays deeply forked at the base.

Although bound by natural ties, the series of families that cluster round the mackerel offer so many modifications of structure that it is almost impossible to draw up a diagnosis differentiating every one of its members from the Perciformes, with which they are closely connected, and from which they hardly deserve to be separated. Even after removing many genera which have been united with them by my predecessors, and which will now be found scattered among various groups of the system, no better definition of the Scombriformes can be given than that the mackerel and horse-mackerel are taken as the pattern-forms around which more or less aberrant types are located, types yet not so aberrant as to be traced back to these familiar forms through a number of intermediate grades. As regards external features, it may be stated that the dorsal and anal spines, if present, are weak and slender, or, if strong, short and detached, the caudal peduncle is constricted, and the caudal fin, if well developed, is usually deeply forked and with the forked bases of the very numerous rays much longer than in most of the Perciformes, embracing at least a considerable portion of the expanded ural bones, a character by which the *Chaetodontidæ*, *Acanthuridæ*, and several extinct types which have been placed with the *Carangidæ* are at once excluded. All are marine and many are pelagic and of very wide distribution. No prætertiary members of this division, as here defined, have yet been found.

Nine families :—

- I. Præmaxillaries more or less protractile, not beak-like ; scales small or absent, sometimes with enlarged lateral scutes ; spinous dorsal short or replaced by a series of isolated spines ; anal usually with one or two spines detached from the rest of the fin.

Præcaudal vertebræ with transverse processes, behind which the ribs are attached	1. <i>Carangidæ</i> .
Præcaudal vertebræ without well-developed parapophyses ; ribs and epipleurals inserted close together on the centra	2. <i>Rhachicentridæ</i> .

II. Præmaxillaries not protractile; scales usually small or absent; body more or less elongate; dorsal fin elongate, single or divided, without free spines; no free anal spines.

A. Pseudobranchiæ present.

- Vertebræ without transverse processes; soft dorsal fin longer than the spinous; pectoral fins high up the sides 3. *Scombridæ*.
 Vertebræ without transverse processes; soft dorsal fin shorter than the spinous, if the latter be distinct; pectoral fin low down the sides..... 4. *Trichiuridæ*.
 Vertebræ without transverse processes; snout produced into a spear 5. *Histiophoridæ*.
 Vertebræ with transverse processes bearing the ribs; snout produced into a sword; no ventrals..... 6. *Xyphiidæ*.
 Vertebræ without transverse processes; gill-membranes attached to isthmus; dorsal and anal fins formed of unarticulated, widely set rays; dentition very feeble 7. *Luvaridæ*.

B. Pseudobranchiæ absent; no well-developed transverse processes to the præcaudal vertebræ, the ribs and the epipleurals inserted close together on the centra; snout short and very deep.

8. *Coryphænidæ*.

III. Præmaxillaries not protractile, or, if slightly protractile, scales large; dorsal and anal fins elongate, without distinct spinous division; most of the præcaudal vertebræ with strong hæmaphyses, to which the ribs are attached. . . . 9. *Bramidæ*.

Division III. ZEORHOMBI.

Aberrant, strongly compressed Perciformes, with very short præcaudal region, modified in the direction of the flat-fishes, culminating in asymmetrical forms, and characterized by the combination of an increased number (7 to 9) of ventral rays, with absence of hypural spine (by which the Berycidæ are excluded), or by asymmetry of the skull in the forms in which the spine of the ventral fin has been lost.

Among the symmetrical forms, the existing Zeidæ agree with the Berycidæ in having more than five soft rays to the ventral fins, and are probably derived, together with the Eocene Amphistiidæ, from some common ancestral group still to be discovered in Cretaceous beds. These Zeidæ have much in common with the Pleuronectidæ* and might be regarded as forming part of the family out of which the latter have sprung, were it not that they have lost the last half-gill. *Amphistium* is probably more nearly related to the Pleuronectidæ, which may have been directly derived from the family of which it is as yet the only known representative †.

* Cf. Thilo, Zool. Anz. 1902, p. 305.

† Cf. Boulenger, Ann. & Mag. Nat. Hist. (7) x. 1902, p. 295.

This division embraces three families only :—

- | | |
|---|----------------------------|
| A spinous dorsal fin ; anal spines detached from the soft portion ; a ventral spine ; gills three and a half, three slits between them..... | 1. <i>Zeidae</i> . |
| Dorsal and anal spines few, continuous with the soft rays ; a ventral spine | 2. <i>Amphistiidae</i> †. |
| No spines ; cranium twisted in front, with the two orbits on one side ; gills four, a slit behind the fourth | 3. <i>Pleuronectidae</i> . |

Division IV. KURTIFORMES.

No bony stay for the præopercle. Dorsal spines feeble, few. Scapula absent, the coracoid supporting four small pterygials. Ventral fins thoracic.

A single family, *Kurtidae*.

Division V. GOBIIFORMES.

No bony stay for the præoperculum. Basis cranii simple. Spinous dorsal, if present, formed of few, flexible rays. None of the epipleural bones attached to the centra of the vertebræ in the præcaudal region. Scapula and coracoid more or less reduced or even vestigial ; pterygials large, 4 or 5 in number, forming together a thin plate which is in contact with or narrowly separated from the clavicle ; one or two of the pterygials in contact with the coracoid. Ventral fins thoracic.

The *Gobiidae*, which alone constitute this division, are not very remote from the Perciformes and may have evolved out of a type not very different from the Percidae.

Division VI. DISCOCEPHALI.

Highly aberrant Acanthopterygians with the anterior dorsal fin modified into a suctorial, transversely laminated oval disk on the head, the skull being very much flattened and with simple basis cranii. The pectoral rays are inserted on the small, perforate, scapula and on four hourglass-shaped pterygials, three of which are in contact with the coracoid. Ventral fins thoracic.

A single family, *Echeneididae*.

In spite of a superficial external resemblance to the genus *Elacate*, the sucking-fish, as first observed by Gill, bear certainly no affinity to that genus nor to other Scombriformes. They are probably derived from Perciformes, but from which family it is impossible to suggest.

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Division VII. SCLEROPAREI. M. 3, 579

Second suborbital bone more or less produced towards or ankylosed with the præoperculum ("suborbital stay")*. Ventral fins thoracic.

The "Cheek-armoured Acanthopterygians," "Joues cuirassées" of Cuvier, after the exclusion of the sticklebacks, form a perfectly natural association, evidently derived from the Serranidæ, with which the more generalized forms have much in common. From the perch-like genus *Sebastes* a continuous series can be traced towards the Triglidæ, especially through such forms as *Apistus*, *Minous*, and *Choridactylus*, in which one or more of the lower pectoral rays are detached from the rest of the fin. Through the Comephoridæ the Scorpenidæ are connected with the Cottidæ, whilst the latter merge insensibly into the still more aberrant Cyclopteridæ. These conclusions, which are apparent enough from a mere comparison of the external characters, become fortified by a study of the skeletons. The passage between the various groups here accepted as families is so complete that no serious objection could be raised to their union in one great family with a number of minor divisions.

The character from which the Scleroparei derive their name is subject to many modifications. The second suborbital (the third, if the præorbital be regarded as the first) may be merely enlarged and prolonged over the cheek towards the præoperculum (*Sebastes*, *Anhoplopoma*), or firmly ankylosed to the latter (*Scorpena*, *Platycephalus*), or form part of the external armature of the head (*Trigla*, *Dactylopterus*). The structure of the base of the pectoral fin appears to afford important characters for the definition of the families, as first pointed out by Gill.

Eleven families :—

I. Head not completely cuirassed.

A. Ventral fins not widely separated; none of the pterygials in contact with the clavicle.

- | | |
|---|------------------------------|
| Two nostrils on each side; basis cranii double;
gill-membranes free from isthmus | 1. <i>Scorpenide</i> . |
| A single nostril on each side; basis cranii double;
gill-membranes free from isthmus | 2. <i>Hexagrammide</i> . |
| Two nostrils on each side; basis cranii simple;
gill-membranes free or narrowly attached to
isthmus | 3. <i>Comephoride</i> . |
| Two nostrils on each side; basis cranii simple;
gill-opening narrow, above base of pectoral . . | 4. <i>Rhamphocottide</i> . > |

* This character suffers one exception, to be found in *Comephorus*, a degraded form otherwise closely related to *Cottocomephorus*, in which the skeleton is typical of the present division.

- B. Ventral fins, if present, not widely separated; one or several of the pterygials in contact with the clavicle.
- Ventral fins distinct; gill-clefts wide 5. *Cottidae*.
- Ventral fins united into a sucking-disk; gill-opening narrow, above base of pectoral 6. *Cyclopteridae*.
- C. Ventral fins widely separated; none of the pterygials in contact with the clavicle.
- Ventral fins behind base of pectorals; præcaudal vertebræ without transverse processes 7. *Platycephalidae*.
- Ventral fins a little in front of base of pectorals; præcaudal vertebræ with transverse processes 8. *Hoplichthyidae*.
- II. Head completely cuirassed.
- Ventral fins narrowly separated; no pectoral appendages; pterygials short and broad 9. *Agonidae*.
- Ventral fins widely separated; 2 or 3 lowermost rays of pectoral fin detached as feelers; pterygials short and broad 10. *Triglidae*.
- Ventral fins narrowly separated; pectoral fin divided into two portions; pterygials elongate 11. *Dactylopteridae*.

Division VIII. JUGULARES.

No bony stay for the præoperculum. Ventral fins jugular or mental. Gill-openings in front of the pectoral fin, the base of which is vertical or subvertical.

In a recently published note * I have alluded to the group of physoclistous fishes for which I propose to revive the old name Jugulares, pointing out that some of the forms previously grouped together as Trachinidæ agree with the Gadidæ, not only in the jugular position of the ventral fins, but also in the condition of the scapula and coracoid.

Mr. Regan † has since been able to show that the Gadidæ and Macruridæ possess certain characters in common by which they may be separated, not only from the other Jugulares, but even from the Acanthopterygians, and, as mentioned above (p. 176), the Müllerian suborder Anacanthini may be maintained, after excluding the Pleuronectidæ. That the Blenniidæ are akin to *Lycodes* and allies has long been admitted, and authors who have placed them in different divisions of their systems have had to confess the difficulty of referring certain genera to the one family rather than to the other. The fact that *Lycodes* and many forms previously associated with the Ophidiidæ agree with the Macruridæ and Gadidæ in the diphycceral vertebral column, and in the

* Ann. & Mag. Nat. Hist. (7) viii. 1901, p. 261.

† *Op. cit.* xi. 1903, p. 459.

absence of spines to the fins, is merely, it seems to me, the result of degradation; they probably form the terminal group of a series in which the vertebral column was originally homocercal and fin-spines were present, as is the case in most of the *Blenniidae* and *Trachinidae* and their near allies. All these families may be assumed to have evolved in several series, often on parallel lines, from some group closely related to the *Berycidae*; the resemblance which their terminal forms bear to the *Anacanthini* is, as recognized by Regan, probably to be ascribed to convergence, not to any close genetic affinity.

Fifteen families:—

- I. Pectoral rays attached to the scapula and to a series of pterygials, of which only one or two are in contact with the scapula; ventral fins jugular, with 1 spine and 4 or 5 soft rays; anterior dorsal rays usually spinous or not articulated, often forming a detached fin.
 - A. Epipleurals present.
 - 1. Second suborbital produced inwards to support the eyeball.
 - Ventrals close together; scales very small, cycloid, forming oblique bands 1. *Trachinidae*.
 - Ventrals widely separated 2. *Percophiidae*.
 - 2. No subocular shelf.
 - Ventrals widely separated; two nostrils on each side 3. *Leptoscopidae*.
 - Ventrals widely separated; a single nostril on each side 4. *Nototheniidae*.
 - Ventrals close together; scales very small, forming oblique bands; head partly covered with bony plates 5. *Uranoscopidae*.
 - B. No epipleurals.
 - Post-temporal forked, articulated to the skull; soft dorsal and anal much elongate 6. *Trichonotidae*.
 - Post-temporal closely adnate to the skull; soft dorsal and anal short (with only 7 to 10 rays).. 7. *Callionymidae*.
 - Post-temporal simple, articulated to the skull; soft dorsal and anal short; a ventral sucker 8. *Gobiesocidae*.
- II. Pectoral rays all attached to the pterygials, of which two or three are in contact with the scapula; ventral fins, if present, jugular or mental, composed of 1 to 4 rays.
 - A. Ventrals jugular or absent.
 - Post-temporal distinctly forked; præcaudal vertebræ with transverse processes; some or all of the dorsal rays spinous or not articulated; caudal fin usually distinct 9. *Blenniidae*.
 - Post-temporal small and ankylosed to the skull; præcaudal vertebræ without well-developed transverse processes; a very short spinous dorsal; caudal fin distinct 10. *Batrachidae*.

- Post-temporal distinctly forked; præcaudal vertebræ with hæmal arches; dorsal rays all spinous; caudal fin distinct 11. *Pholididæ*.
- Post-temporal distinctly forked; præcaudal vertebræ with transverse processes; dorsal rays all articulated, or a few of the posterior spinous; no distinct caudal 12. *Zoarcidæ*.
- Post-temporal forked, ankylosed to the skull; præcaudal vertebræ with transverse processes; no spines; no distinct caudal 13. *Congrogadidæ*.
- B. Ventrals mental (just behind the chin); no spines.
14. *Ophidiidæ*.
- III. Pectoral rays attached to an undivided cartilaginous plate representing the pterygials; ventral fins jugular, reduced to a filament formed of two adnate rays; fins without spines.
15. *Podatelidæ*.

Division IX. TÆNIOSOMI.

Exceedingly compressed, more or less elongate, often ribbon-like fishes of doubtful affinities, probably related to the earlier Acanthopterygians, the ventral fins, when well developed, comprising as many as 7 to 9 rays. Dorsal fin extending from the head to the end of the tail, its rays simple (separable into lateral halves), the anterior often prolonged; anal fin very short or absent. Pectoral fin with horizontal, or nearly horizontal, base, the rays supported by the scapula and by three short pterygials, all three, or two at least, of which are related to the coracoid. Ribs small and slender, or absent. Post-temporal simple and solidly attached to the skull. Scales minute or absent.

Deep-sea or pelagic fishes from the Atlantic and Mediterranean and from the Pacific; specimens are rare in collections and the life-histories are still very imperfectly known, although it has been ascertained that great changes of form take place with growth.

Only two families :—

- Mouth very protractile; ventral fins more or less developed, with 6 to 9 rays, or reduced to a single long ray; no anal fin; vent about the middle of the body; caudal rays, if present, divided into two fascicles, the upper sometimes much prolonged and directed upwards. 1. *Trachypteridæ*.
- Mouth moderately protractile; ventrals very small, if distinct, with 4 or 5 rays; body-cavity extending nearly the whole length of the much elongate body, the vent very far back and followed by a short anal fin; caudal fin small, not divided 2. *Lophotidæ*.

Suborder XI. OPISTHOMI.

Air-bladder without open duct. Opercle well developed, hidden under the skin; supraoccipital in contact with the frontals, separating the parietals. Pectoral arch suspended from the vertebral column, far behind the skull; no mesocoracoid; no clavicle distinct from the cleithrum. Vertical fins with spines. Ventral fins absent.

This division stands in the same relation to the Acanthopterygii as the Apodes to the Malacopterygii. The single family, *Mastacembelidæ*, inhabiting the fresh waters of Southern Asia and Africa, is possibly derived from the Blenniidæ.

Suborder XII. PEDICULATI.

Air-bladder without open duct. Opercle large, hidden under the skin; supraoccipital in contact with the frontals, separating the parietals. Pectoral arch suspended from the skull; no mesocoracoid. No ribs, no epipleurals. Ventral fins jugular. Gill-opening reduced to a foramen situated in or near the axil, more or less posterior to the base of the pectoral. Body naked or covered with spines or bony tubercles.

A small natural group, connected with the Acanthopterygii Jugulares through the Batrachidæ, in which the elongate pterygials of the pectoral fin foreshadow the kind of arm ("pseudobrachium") which is more or less characteristic of these highly aberrant fishes. As in the Batrachidæ, the post-temporal is flat and ankylosed to the cranium, and the suprascapula is much elongate. The pterygials, two or three in number, are separated from the small scapula and coracoid by a broad ligament, the arm-like pectorals being more or less distinctly geniculated and inserted far back behind the cranium. The head is large, the basis cranii simple. The gills are reduced to 2, $2\frac{1}{2}$, or 3. The spinous dorsal, if present, consists of a few rays, which may be modified into tentacles inserted on the head.

Five families:—

I. Gill-opening in or behind lower axil of pectoral; mouth large, terminal or directed upwards.

Pectoral fin scarcely geniculated; ventrals present . . . 1. *Lophiidæ*.
 Pectoral fin scarcely geniculated; ventrals absent . . . 2. *Ceratidæ*.
 Pectoral fin strongly geniculated; ventrals present . . . 3. *Antemariidæ*.

II. Gill-opening behind lower axil of pectoral; mouth inferior; ventrals absent 4. *Gigantactinidæ*.

- III. Gill-opening above axil of pectoral; mouth rather small, sub-terminal or inferior; pectoral fin strongly geniculated; ventrals present; spinous dorsal absent or reduced to a small tentacle lodged in a cavity under the snout 5. *Malthide*.

Suborder XIII. PLECTOGNATHI.

Air-bladder without open duct. Opercular bones more or less reduced; supraoccipital in contact with the frontals, separating the parietals; maxillary and præmaxillary bones often firmly united. Pectoral arch suspended from the skull; no mesocoracoid. No ribs. Ventral fins thoracic and much reduced if present; the pelvic bones, if present, more or less completely co-ossified. Gill-opening much reduced. Body covered with more or less osseous scales, bony scutes, or spines, or naked.

A highly aberrant group, closely connected with the Acanthopterygii through the Acanthuridæ, as pointed out long ago by Dareste*. The skeleton is often feebly ossified and the vertebræ much reduced in number, but the jaws, although short, are very strong, usually with large sectorial teeth which may be confluent into a beak; the post-temporal is short and simple, suturally united to the squamosal. These fishes have usually been arranged in three divisions: Sclerodermi, Ostracodermi, and Gymnodontes; but Regan †, whose classification is here followed, has shown that the latter include a type (*Triodon*) which, in spite of its beak-like teeth, is more nearly related to the Sclerodermi, whilst the Ostracodermi have much more in common with the latter than with the Gymnodontes. It therefore appears best to admit only two divisions, the first with four, the second with three families:—

I. SCLERODERMI. Supraclavicle vertical; pectoral arch of the Perciform type; all the vertebræ with a single neural spine.

A. Body covered with hard or spinous scales; epipleurals present; pelvis present.

Teeth separate; spinous dorsal present; ventrals paired; pelvis immovable 1. *Triacanthidæ*.

A beak; spinous dorsal and ventrals absent; pelvis movable 2. *Triodontidæ*.

Teeth separate; spinous dorsal present; ventrals absent or represented by a single short spine; pelvis movable 3. *Balistidæ*.

B. Body encased in a carapace; no epipleurals; spinous dorsal, pelvis, and ventrals absent 4. *Ostraciontidæ*.

* Ann. Sci. Nat., Zool. (3) xiv. 1850, p. 105, and C. R. Ac. Sci. lxxiv. 1872, p. 1527.

† P. Z. S. 1902, ii. p. 284.

II. GYMNOTONTES. Supraclavicle oblique or nearly horizontal; lower three pterygials enlarged and immovably united to the coraco-scapular cartilage; anterior vertebræ with bifid divergent neural spines; pelvis absent.

- Beak with a median suture; interoperculum not connected with suboperculum; three gills; caudal fin present; body inflatable 5. *Tetrodontidæ*.
 Beak without median suture; interoperculum attached posteriorly to suboperculum; three gills; caudal fin present; body inflatable 6. *Diodontidæ*.
 Beak without median suture; interoperculum attached posteriorly to suboperculum; four gills; caudal fin absent, the body non-inflatable, truncate posteriorly, with the dorsal and anal fins confluent 7. *Molidæ*.

XX.—On a Collection of Fishes made by Mr. John Graham at Yunnan Fu. By C. TATE REGAN, B.A.

THE British Museum has received from Mr. John Graham a small collection of fishes from the large lake "Sea of Tien," on the north shore of which the city of Yunnan Fu is situated. This lake is at an altitude of about 6000 feet above the sea-level, and its overflow runs northwards by the Pulu-shing to the Yang-tse-kiang. Of thirteen species represented, eight are described below as new to science. The complete list is as follows:—

1. *Cyprinus carpio*, L.

The two specimens received both lack the anterior barbel*, and should perhaps be referred to a distinct subspecies on this account. Six examples in the British Museum Collection, from the Southern Shan States, with large scales, 26–29 $\frac{4-5}{6-7}$, may also be regarded as belonging to a geographical race or subspecies.

2. *Barbus Grahami*, sp. n.

Depth of body $3\frac{1}{2}$ times in the total length, length of head $3\frac{3}{4}$ times. Snout nearly twice as long as the eye, the diameter of which is $5\frac{2}{3}$ times in the length of head and $1\frac{1}{2}$ times in the interorbital width. Mouth subterminal, maxillary not extending to below the eye. Two barbels on each side, the anterior $\frac{3}{8}$, the posterior nearly $\frac{1}{2}$ the length of head.

* Some of the specimens figured in Reeve's drawings of Chinese fishes have apparently no anterior barbel.